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EDUCATION OF SCIENCE TEACHERS – SOME REMARKS FROM THE POLISH PERSPECTIVE

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Abstract

Science education becomes more and more important in contemporary society. Its effects depend mainly on teachers. No wonder that in many countries the problem of science teachers' education becomes of significant importance. This article presents topical problems connected with education and improvement of science teachers in Poland. First of all, there will be characterized the ways leading to obtain qualifications for doing teacher's job, the regulations and important factors affecting the course and results of science teachers' education. Then after discussing main principles governing science teachers' education, their practical application will be presented based on the example of chemistry teachers' education at M.C. Skłodowska University.
Key words: science education, education of teachers.

Introduction

Education of science teachers in Poland has been constantly changing during the last few years. First of all, this a result of the educational system reform carried out a few years ago. According to the current compulsory educational structure pupils start learning in the six-year Primary School. Another stage of compulsory education is the three-year Junior Secondary School. Then learning can be continued in the three-year Senior Secondary School ending with the school final exam. In the Primary School there is introduced a new subject "science" which is taught in the grades from 4 to 6. In the Junior Secondary School the science subjects (biology, chemistry, physics and astronomy as well as geography) are taught on the average 4 hours of each subject distributed in the period of three years; e.g. 2 hours of biology weakly in the first form and 2 hours in the second form. In the Senior Secondary School on the average 3 hours of each subject during the first two years are taught, obligatory for all pupils. During the third year maximum 8 hours are optional for one or two of these subjects in the classes of suitable range of interests. Each of these levels of teaching requires suitably educated science teachers.

Moreover, the educational system reform involved also essential changes in curricula and basically different approach from the previous one which means different methods of teaching. First of all revaluation of teaching aims took place evidenced in divergence from teaching based on memorizing often useless information by pupils and paying more attention to understanding knowledge being acquired and ability to use it. It is assumed that school should train skill of universal character as well as form and develop attitudes important as regards further development of pupil and his future life in the society. That requires from teachers application of teaching methods developing cognitive activity and engagement of pupils. At the same time, the teacher should analyse the course and effects of his work with pupils and improve his teaching accomplishments. Moreover, the possibility created by the reform of a few or even several handbooks for a given subject functioning at the same time provides a serious task of choosing an optimal curriculum and handbook.

Necessity of changes in teachers, education was pointed out in the Report of the National Inspectorate published in 2001 including some incorrectness in this aspect. Most students were

educated in the inspected universities based on the curricula not obeying the regulations for this type of studies. In many cases the staff members educating prospective teachers were not well prepared for this task. Also the organization of teacher practical placement in school which should be the main place for acquiring teaching skills, was questioned. Little care was attached to didactic and educational supervision of proper course of teacher practical placement in school by the university workers responsible for them. The universities were not sufficiently equipped with computers and multimedia teaching aids which made it impossible to prepare properly prospective teachers to use computers. In more than half universities libraries did not possess the latest curricula and handbooks prepared according to the assumptions of the new educational system introduced a few years ago for teaching in primary schools and junior secondary schools.

Another factor affecting science teachers' education in Poland is developing international cooperation. There are more and more possibilities of using achievements of other countries in this field owing to better access to literature and participation in various conferences and symposia organized in different foreign countries. Lately many Polish universities educating teachers took part in realization of the TEMPUS projects and at present participate in the SOCRATES-COMENIUS projects. The experience and funds obtained in this way are used for modernization of curricula and methods of science teachers education.

This article presents topical problems connected with education and improvement of science teachers in Poland. First of all, there will be characterized the ways leading to obtain qualifications for doing teacher's job, the regulations and important factors affecting the course and results of science teachers' education. Then after discussing main principles governing science teachers' education, their practical application will be presented based on the example of chemistry teachers' education at M.C. Skłodowska University.

Some information about the system of science teachers' education in Poland

The Minister of National Education determines qualifications required of teachers and the minimum number of hours assigned for profesional preparation. According to the current regulations issued by the Minister on September 23, 2003, this preparation must comprise a minimum of 480 hours, including:

- 150 hours in pedagogy and psychology;
- 120 hours in subject teaching methods;
- 60 hours of so called complementary courses which, besides obligatory lessons in voice production contain humanistic subjects like ethics, language culture, history and region culture etc.;
- 150 hours (10 weeks) of a teacher practical placement in school.

The outline of teacher specialization graduate included in the above mentioned regulations, which describes his/her competences, besides knowledge in psychology, pedagogy and subject didactics, includes substantial knowledge of a given subject as well as the use of information and communication technologies in teaching. A quite new thing is also demand from the prospective teacher to know at least one foreign language on the advanced level.

The education of teachers in higher education institutions is mostly provided within the fields of study which prepare specialists for various professions (e.g. studies in the field of chemistry, biology, physics etc.). The students may choose a teacher's specialisation and acquire teacher's qualifications as part of their studies. Another way is to complete studies without such specialisation and acquire teacher's qualifications upon completion of post-graduate studies or qualification courses. Getting credits of the professional course during the 5-year studies [M.Sc.] qualifies for teaching in the Junior and Senior Secondary Schools. Moreover there are the 3-year professional teacher studies [B.Sc.] which qualifies for teaching only in the Junior Secondary School.

Higher education institutions train mostly teachers of one specialisation, though recently they have also started to introduce studies covering two specialisations (two subject teachers), mainly combining related specialisations (e.g. chemistry with biology or physics, biology with environmental protection, etc.). Teachers may also be prepared to teach a second subject in the post-graduate studies lasting 3 to 4 semesters.

Current system of science teachers' education is not successful. There are many reasons of it. Despite more precisely defined conditions of acquiring qualifications for doing a teachers' job in above quoted decree compared with the previous regulations, there is still lack of compact and sufficiently precise conceptions regarding preparation for this profession. As a result, level of teachers' education in individual universities differs greatly. Self-governing of higher education institutions giving powers for elaboration of curricula and freedom in maintaining standard of teaching has unfavourable influence. The graduates of the universities focusing attention only on formal observance of very general regulations presented earlier, can obtain credits from suitable subjects but it does not mean acquiring essential skills indispensable for doing teachers job.

The standard of teacher education depends also on the teaching staff preparation. The results of studies presented in Report (Janiuk et al., 2002) elaborated by the Commission for Science Education within the Polish Scientific Societies show that many university teachers didactics of science subject do not possess experience of teaching at school or theoretical knowledge provided by specialistic literature and they have never carried out studies in the didactics of a given subject. Also difficulties in obtaining scientific degrees in the field of didactics affect unfavourably development of scientific staff.

The activities taken by the National Accreditation Commission will surely affect the changes in teacher education before long. It is authorised to evaluate education quality and to control conditions of higher education in all Polish Universities. Its activity includes also evaluation of teacher education. It began the works in 2002, so far focusing mainly on analysis of functioning of some subjects of studies. One can expect it will deal with curricula and quality of the courses preparing for the teacher profession. Undoubtedly, this will promote better preparation of prospective teachers for doing their job.

Another problem deciding about quality of prospective teachers education are motives of students while choosing the courses providing suitable qualifications. For a long time there has been observed gradual decrease of teacher profession prestige in the society. This fact is due to many reasons, of which the most important is relatively law salary and the common negative opinions about the education condition. As a result a smaller and smaller number of students enrolling for the course providing teaching qualifications, is really willing to become teachers. They are rather motivated by security in case not finding a more desirable job after being graduated.

Describing the situation in education of science teachers, one should mention about difficulties which appear a few years ago when a new subject "science" was introduced into Primary Schools. Its teaching is greatly demanding as far as teachers are concerned. They should have good basic knowledge from all science subjects and be able to guide pupils' cognitive activity. Unfortunately, science teachers in Primary School are recruited mainly from the hitherto teachers of science subjects (mostly biology). Their preparation for the new task consisted in finishing a two-semester postgraduate studies. Though some time passed, a new subject of studies giving full qualifications for teaching science has been introduced at any Polish university. All of this can have negative influence on level of science knowledge acquired by pupils' in Primary School and then on the process of learning science subject in Junior Secondary School.

After starting teacher's job it is possible to attain the following categories of profesional promotion:

- trainee teacher;
- contracted teacher;
- appointed teacher;

- chartered teacher.

Promotion to higher category will require the upgrading of qualifications and pay rises will be tied to the teaching post category and teaching performance. The teacher may be promoted to a given category if he/she:

- holds required qualifications;
- has completed a practical placement which ended with a favourable assessment of his/her achievement during the placement (the placement is based on the individual skill development programme);
- has been accepted by the selection committee or, in the case of the contraction teacher, has passed an examination conducted by an examination board.

One of the conditions for teacher's promotion are postgraduate studies or other forms (courses) of professional improvement. The postgraduate studies usually organized by higher education institutions provide qualifications for teaching of other related subjects. Another type of such studies enables improvement of professional qualifications in the range of the taught subject.

Education of science teachers at M. Curie-Sklodowska University

Good preparation for teacher's job is difficult task requiring constant search for better curricula and organisation of the studies (Janiuk, 1998b). Therefore during the last few years in the Faculty of Chemistry thorough modification of the classes for chemistry teacher education has been made. It was possible owing to the experience and cooperation of the persons conducting the classes in didactics of chemistry, pedagogy and psychology. Of significant importance was also participation of our University in the realization of the project "Science Teachers Education Programme" within the Tempus program (Janiuk, 1998a). That provides opportunity for financing many conceptional works concerning curriculum changes and purchase of laboratory equipment.

Professional qualifications of science teachers as well as teachers of other subjects are affected by (Janiuk, 1997):

- basic knowledge of a given subject (physics, chemistry, biology);
- knowledge how to teach given subject;
- knowledge needed by teacher as an educator.

The curriculum of a well planned course qualifying for the teachers' job should include the above mentioned elements combining them in a uniform way.

The group of subjects taught for three semesters giving qualifications for teaching are didactics of chemistry (120h), pedagogy (90h), psychology (60h) and school practice (2 weeks of pedagogical training and 8 weeks of subject – method training). Professional training begins in the fourth year of studies (semester VII) from the classes in didactics of chemistry and pedagogy (Fig. 1). Classes in psychology are in a successive semester. Such a sequence results from the belief that before classes in psychology, students should acquire basic theoretical and practical knowledge of didactic-educational process which will enable greater engagement in these classes being aware of the importance of knowledge from the field of psychology in the teacher's work. It is worth mentioning the regular contacts of all the teachers of the above mentioned subjects which makes possible earlier arrangements of relations between subjects as well as exchange of information about existing problems.

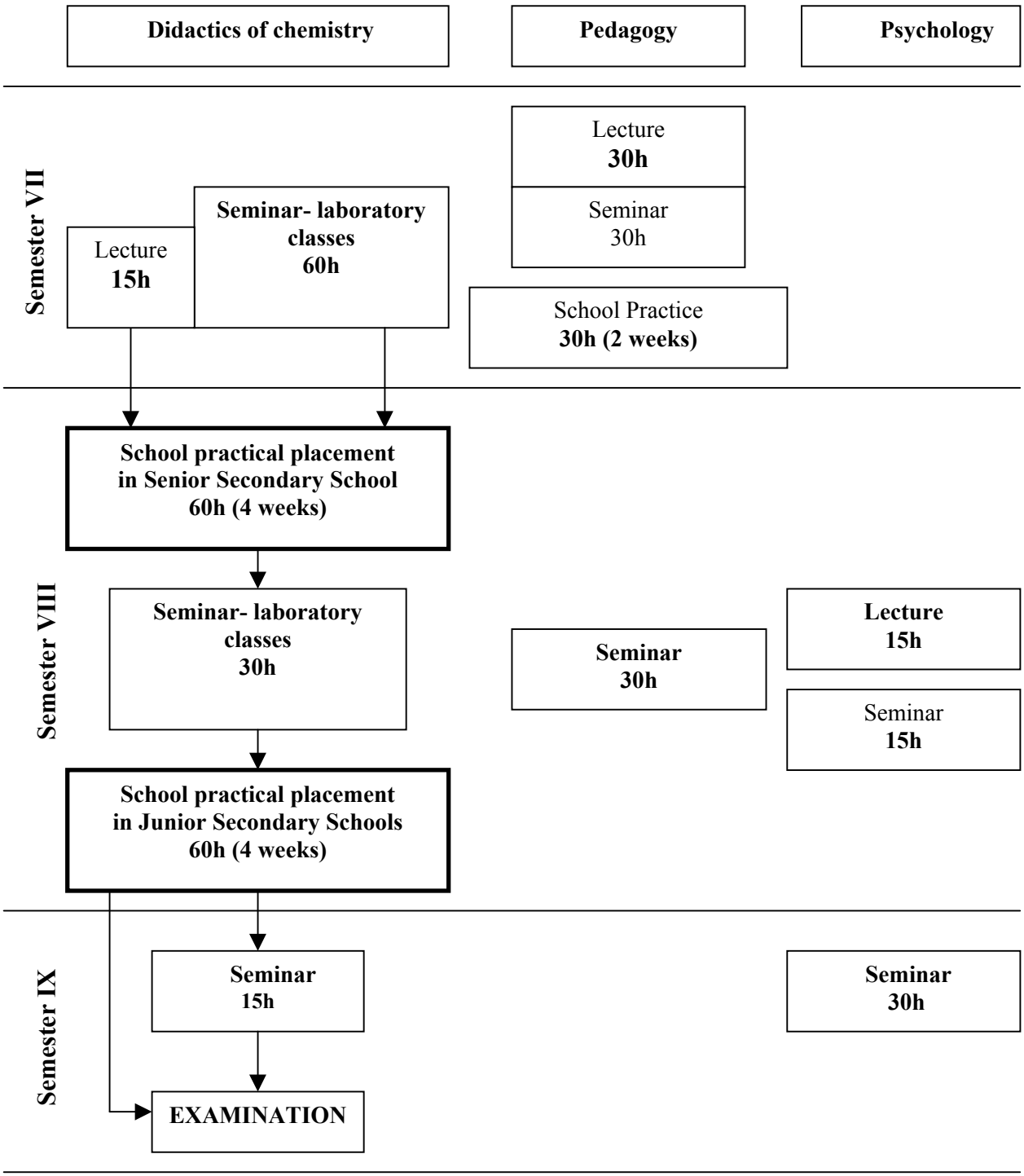


Figure 1. Structure of course qualifying for teaching chemistry in the Faculty of Chemistry, M.Curie-Skłodowska University, Lublin.

While preparing the new curriculum for a profesional course for prospective chemistry teachers which has been in force since the academic year 1999/2000 it was assumed that the graduates should possess all essential skills indispensable for this job. That required making a list of the skills connected with didactics of chemistry, pedagogy and psychology. This in turn was the starting point in preparing curricula of given classes in such a way that students were able to to acquire these skills. In the case of chemistry didactics they were as follows:

1. Planning of teacher's work (long term)
   (e.g. making the analysis of chemistry teaching including teaching aims and teaching content structure).
2. Preparation of the workplace
   (e.g. making a list of essential equipment and reagents necessary for school chemical laboratory)
3. Preparing and conducting lessons
   (e.g. choice of teaching methods and teaching aids indispensable for realization of the assumed aims).
4. Analysis and verification of the methods used
   (e.g. preparation of the test for pupils checking the knowledge presented in a given part of the curriculum)
5. Other kinds of teacher's activities
   (e.g. preparing project for the extra-lessons in chemistry)

The structure of didactics of chemistry classes resulted from the assumption that the best and complete possibilities of acquiring skills necessary for chemistry teachers are provided by school, therefore the school practical placement occupies a key role in this structure. Of 8 weeks planned for them, four weeks are designed for the training course in senior secondary schools during the second semester in the fourth year of studies. The other four weeks of the training course take place in junior secondary schools in September before beginning the fifth year of studies. As a result arrangement and contents of didactics of chemistry classes are conformed to school practical placement. The classes in semester VII precede the first school practical placement and provide the basic skills for planning, preparing and conducting the lessons. During the classes in semester VIII along with the school practical placement improvement of the acquired skills and forming next ones necessary for the chemistry teacher take place.

The didactics of chemistry curriculum included: lecture (15h, semester VII), seminar-laboratory classes (60h in semester VII 30h in semester VIII) and seminar (15h, semester IX) as well as the school practical placement.

The aim of the lecture is to present the problems connected with the work of chemistry teacher and to provide essential information useful for acquiring suitable skills. Besides common subjects like teaching aims, methods and teaching aids in teaching chemistry, the other problems such as origin and structure of chemical knowledge as well as learning chemistry process are discussed.

Seminar-laboratory classes aim at providing students gradually with the skills necessary in the future professional work which will be practised and improved during school practical placement. While preparing these classes, the attempt was made to conform suitable skills to successive classes based on the earlier worked out list.

During the first 60 hours of these classes, students learn, among others:

- to determine and formulate cognitive aims of the lesson;
- to choose chemical experiments for cognitive aims of the lesson;
- to guide a reasoning process of pupils while acquiring new knowledge;
- to use curricula in planning the lesson;

- to use the models of matter structure to explain and predict chemical facts;
- to use chemical experiments and other audio-visual aids (overhead projector) to achieve the assumed teaching aids.

During successive 30 hours of classes in the next semester when the students have got some experience from the school practical placement, they acquire further skills, among others, in:

- using the Internet and multimedia device;
- evaluation of pupils' school achievements;
- introducing problems in the field of environment protection during the chemistry lessons;
- planning realisation of some contents of education (carbohydrates, chemistry in everyday life);
- basing on the knowledge of other science subjects in teaching chemistry;
- applying the methods promoting cognitive activity of pupils.

In planning seminar-laboratory classes there were taken into consideration all important factors which could influence on their course and consequently, on the skills being acquired by students. During the first classes, which are of organizational character, the students complete the questionnaire whose aim is toobtain information about their attitude to the teacher's job, reasons for choosing a group of subjects giving qualifications for doing teacher's job and expectations about the classes in didactics of chemistry. Additional and very important aim of the questionnaire is to create already at the beginning of classes possibilities for discussion about work of chemistry teacher. That promotes creating positive attitudes of students towards participation in these classes. The motivation factor, essential in each activity, was taken into consideration while planning the classes in all possible situations. The example can be the fact that the classes are held at school where students attend the lesson conducted by an experienced chemistry teacher. They can realize how wide range of skills the teacher must have to make the lesson interesting and effective and also how much depends on the proper attitude towards the job you are doing.

Acquiring new knowledge, whether it is information or skill, the activity of the learner plays an important role. Therefore planning the seminar – laboratory classes it was assumed that they will consist mainly in doing the tasks by students leading to "discovery" of individual elements of knowledge in the field of chemistry didactics and to suitable skill acquisition. This requires basing on the experience when they were pupils and also on the example observed during the lessons they attended or reproduced from a vast collection of video recordings prepared earlier, presenting the course of the lessons conducted by the best chemistry teachers.

A typical example of the classes conducted in this way can be an exercise dealing with teaching rules. The students usually learn about them during the lecture or from the textbook. Doing a given task, they analyse suitably chosen educational situations and formulate rules. The knowledge acquired in this way is then verified during lectures, lesson attendance and referring to suitable literature. Another example for showing the way to acquire new skills by students, can be a task how to make chemical experiments. It enables students getting acquainted with the choice of the way how to carry out experiments depending on the assumed teaching aims. They get to know technical and didactic aspects of making experiments as well as how to keep the safety conditions. Similarly, during the classes on importance of theories of matter structure in acquiring chemical knowledge by comparing different ways of presenting models referring to these theories, the students learn how to use them to create conceptions about matter structure and to carry out reasoning in order to explain or predict chemical facts. Still another example can be tasks done by students in order to get to know how to make use of Internet and multimedia in teaching chemistry.

For each classes there are special work sheets including the information about the assumed aims and description of individual tasks to be done by students. Doing these tasks, the students write the obtained effects and conclusions in suitable places on the work sheets. The work sheets are checked before next classes and in the case of doubts and problems they are discussed with students.

The skills acquired during chemistry didactics classes can not be confined only to the process of teaching this subject. Therefore whenever possible the knowledge acquired during the classes in pedagogy and psychology is consolidated which refers to the course of learning process, teacher – pupil relations and the role of teacher-educator in the educational process. Much attention is paid to the problems connected with the changing situation in the educational system. This includes, for example national exams which started already last year, multidisciplinary educational paths, new curricula and handbooks as well as teaching aids etc. If possible other problems concerning everyday work of teachers, like requirements for profesional promotion are discussed during classes.

A number of hours of classes meant for learning about possible use of computers in teaching has been increasing lately. Which can take place thanks to the sufficient number of computer stands in the laboratory. Students get familiar, among others, with the use of the Internet in teachers' work, learn how to use multimadia programs during chemistry lessons and also prepare teaching aids by themselves by means of computer techniques.

During practical placement at school, on one hand the students can test their skills acquired during the classes at the university and on the other hand, they train new skills which they will be able to develop and improve during further classes at the university. The experiences from the school practical placement should make them aware of the importance of systematised knowledge in didactics of chemistry field which they get to know during these classes.

The choice of type of school for the practical placement is not accidental. The first practical placement takes place in the Senior Secondary School. However, the substantial knowledge required for conducting lessons on this level is greater than in the Junior Secondary School but easier as far as teaching methods are concerned. The second practical placement takes place in the Junior Secondary School. The level of pupils' knowledge in this stage is more differentiated and in the earlier intellectual development than in the Senior Secondary School. Conducting lessons in the Junior Secondary School requires more skills and experience, which is confirmed also by students. Another factor is more serious educational problems with pupils which students encounter during the practical placement in the Junior Secondary School.

Testing students' skills takes place in the final period of the practical placement when students got used to school, got to know pupils and working conditions. Then the lessons conducted by them are attended and evaluated by the teacher and the supervisor of the school placement practice who is the university worker. The evaluation is made using the especially prepared lesson analysis sheet. Using this sheet a few skills are evaluated, among others: the preparation of scenario of the lesson, choice of a suitable teaching method, using teaching aids, activating pupils, emphasising importance of chemical knowledge etc. Positive evaluation of the attended lesson is necessary, though it is the condition of crediting the school practical placement. The students' skills tested during the final subject – didactics of chemistry courses are also part of an exam in chemistry education.

After finishing the school practical placement the students still participate in the seminar which takes place in semester IX. Its aim is to sum up and consolidate the knowledge acquired during two semesters of didactics of chemistry classes and practical placement at school. It consists in successive activities connected with preparation for realisation of the chosen section in the curriculum of chemistry teaching in the junior or senior secondary schools and then in their analysis. This creates the occasion for students to make aware that teacher's job is not copying the same procedures all the time. They also see that the ability of critical analysis of curricula, handbooks, choice of teaching aids as well as verification of effects of one's own work and improvement of professional skills are of significant importance. In many cases students must refer to their chemical knowledge. Then it proves that in some cases they have difficulties with presenting some chemical problems in a simple way comprehensible for pupils and they also become aware of the gaps they possess in their chemical knowledge. This is the starting point for

another thought about significance of good command of subject knowledge, which they must deliver to pupils.

The exam in the didactics of chemistry which ends this course of classes is to perform an important function as passing it is confirmation of qualifications for becoming a chemistry teacher. It consists of a few elements whose aim is to check:

- the extent of chemical knowledge acquisition in the scope of junior and senior secondary schools;
- knowledge in didactics of chemistry;
- abilities for planning teaching and educational activities;
- abilities for conducting the lesson.

The best students who obtained very good results during all classes in chemical education and the lesson conducted by them during the school practical placement was highly evaluated are dispensed from taking the final exam.

The studies educating teachers of other science subjects at Maria Curie-Sklodowska University are of similar character. After graduating and taking a job as a teacher a large number of those finishing the studies attends the postgraduate studies at our University to improve their qualifications. Generally, they are fee-paid studies, though in the last few years, after introducing the educational reform they were financed by the National Ministry of Education. Most people attending them were teachers wanting to acquire powers for teaching science in Primary School. It should be also mentioned about other activities made by our University affecting the work of Science teachers. Regular meetings are arranged during which teachers are informed about new achievements in science subjects teaching. Teachers often get in touch with us when they need help in their everyday professional activities. Our University was also an organiser of the international course in 2000 in which several chemistry teachers from the Central and East European countries took place.

The problems connected with education of science teachers in Poland presented in this paper practically occur in other countries. Simultaneously with the increasing importance of science education in contemporary society, the requirements for better teachers' qualifications will become larger. Therefore development of international cooperation thanks to which searching for common ways of more effective science teachers education is possible, is of significant importance.

Conclusions

As results from the presented analysis the quality of science teachers education is mainly affected by the following factors:

- suitable requirements concerning the way and conditions of teachers education resulting from the policy of given country in this respect;
- proper choice of candidates for studies mainly conditioned by the situation in the society;
- ways and conditions of education provided in individual universities.

A direct influence of science teachers' educators is possible only for the last factor. Therefore proper planning of the teacher education process and providing good conditions at each university play an important role. This requires creating a team of people engaged in this kind of job and at the same time searching for better organization and teaching methods used in this process. Precise description of aims resulting from the professional profile of the science teacher is significant in planning of science teacher education. Its aim should be first of all acquisition of proper skills by the students, indispensable in work of prospective teachers. In this context development of international cooperation, thanks to which searching for common ways of more effective science teachers' education is possible, assumes significant importance.

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Резюме

НЕКОТОРЫЕ ЗАМЕЧАНИЯ ПО ВОПРОСУ ОБРАЗОВАНИЯ УЧИТЕЛЕЙ ЕСТЕСТВЕННЫХ ПРЕДМЕТОВ: ПОЛЬСКИЙ ОПЫТ

Рысзард М. Янюк

Подготовка учителей естествознания в Польше постоянно изменялось в течение прошлых нескольких лет. Прежде всего, это - результат реформы образовательной системы, выполненной несколько лет назад. Эта реформа вызвала существенные изменения в структуре образовательной системы, так же в учебных планах и в системе методов обучения естествознания. Развитие международного сотрудничества здесь играет важную роль.

Подготовка учителей естественных предметов в учреждениях высшего образования главным образом обеспечено в пределах областей студий, которые готовят специалистов к различным профессиям (например студии в области химии, биологии, физики и т.д.).

Студенты могут выбрать специализацию учителя и приобрести квалификации учителя как часть их студий. Другой путь - закончить студии без такой специализации и приобрести квалификацию учителя после завершения основных студий или на курсах квалификации. Есть много причин, что сегодняшняя система подготовки учителей естествознания не успешна. Нехватка компактных и достаточно точных концепций относительно подготовки к этой профессии играет существенную роль.

Хорошая подготовка к работе учителя - трудная задача, требующая постоянного поиска лучших учебных планов /программ/ и организации студий. Хорошим примером могут быть действия, предпринятые в подготовке учителей химии в университете имени Мария Кюри Склодовска в течение прошлых нескольких лет.

Группа предметов, преподаваемых в течение трех семестров, даёт квалификации обучения - дидактика химии (120 часов), педагогика (90 часов), психология (60 часов) и школьная практика (2 недели педагогическая и 8 недель по предмету обучения).

Курс дидактики химии состоит: лекции (15 часов, семестр VII), семинары и лабораторные занятия (60 часов в VII семестре и 30 часов в VIII семестре) и семинары (15 часов, семестр IX) так же школьная практика (4 недели в течение VIII семестра и 4 недели после VIII семестра).

В течение школьной практики, с одной стороны, студенты могут проверить свои умения и навыки, приобретенные в течение занятий в университете и, с другой стороны, они приобретает новые умения и навыки, которые они будут способны развивать и улучшать в течение дальнейших занятий в университете.

После окончания школьной практики все студенты еще участвуют на семинаре, цель которого состоит в том, чтобы подвести итоги и объединить знания, приобретенные в течение двух семестров изучения дидактики химии и знаний, полученных в школе во время практики.

Экзамен по дидактике химии (которым заканчивается этот курс) должен выполнить важную функцию – это подтверждение квалификаций, чтобы стать учителем химии.

Экзамен состоит из нескольких элементов, цель которых состоит в том, чтобы проверить:

- степень приобретенных знаний по химии в пределах средней школы;
- знание по дидактике химии;
- способности планировать обучение и другую образовательную деятельность;
- способности проводить урок.

Проблемы, связанные с подготовкой учителей естествознания в Польше, фактически существует и в других странах. Одновременно с увеличением важности естественнонаучного образования в современном обществе, требования к квалификации учителей постоянно возрастают. Поэтому развитие международного сотрудничества способствует поиску общих путей более эффективной подготовки учителей естествознания.

Ключевые слова: естественнонаучное образование, подготовка учителей.

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